Popular Article

Trends in Agriculutre Science ISSN:2583-7850

Vol.2 Issue 7 July 2023, Page: 552-558

Drone Technology for Agricultural Advancement in India

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https://doi.org/10.5281/zenodo.8184515

Abstract

Agriculture is an indispensible contributor to the economic growth and food security of any nation in the world. However, the global as well as Indian agriculture systems are faced with massive challenges particularly pertaining to food security. The Food and Agriculture Organization (FAO) has stated that by 2050, we would need increase food production by 60% to cater to the needs of a global population of 9.3 billion people. There are also issues related to sustainability of current agricultural practices, for meeting the present and future needs of such a large population. Threats like environmental pollution, climate change, insect and pest attacks, crop failure and fertilizer intensive traditional farming also pose increasing risks in existing agricultural systems. In addition, labour shortages and high labour costs, lack of suitable agricultural inputs and input wastage are issues that are restricting people's access to healthy food. Hence, we must use more advanced technologies to find ways to make our current farming practices and procedures better in order to mitigate such challenges. Drone technology in agriculture has brought with it new opportunities to improve agricultural productivity. Agricultural drones have various applications like crop assessment and crop monitoring. Other uses for drones in agriculture also include soil analysis, geo-fencing, precision agriculture, livestock monitoring and irrigation management.

INTRODUCTION

Agriculture is undoubtedly, an indispensable source of livelihood for the farmers of India. However, a developing nation with an ever-growing population like India is always at the centre of a pool of growing issues and challenges particularly pertaining to agriculture. There are issues related to sustainability of current agricultural practices, for meeting the present and future needs of such a

large population. Threats like environmental pollution, climate change, insect and pest attacks, crop failure and fertilizer intensive traditional farming also pose increasing risks in existing agricultural systems and their capability to cater to the food needs of 1.4 billion people in India. But where there are challenges, there are also new opportunities to fly higher, and for that we can look to new emerging technologies such as drones to be the wings of agricultural advancement. The introduction of drone technology in agriculture has uncovered endless possibilities in evidence based planning and geographical data collection to aid agriculture. It allows for an opportunity to predict and anticipate crop failures thus proving beneficial to farmers in India and all across the globe.

Agricultural Drones

Drone (Dynamic Remotely Operated Navigation Equipment) is an Unmanned Aerial Vehicle (UAV) or a flying robot that can be controlled remotely or operated autonomously with the help of integrated system of software-based flight plans that work with the help of a global positioning system (GPS) and onboard sensors. It consists of two main parts, the control system and the drone. A mobile application or a remote can be used as control. Drones can operate in difficult terrains which cannot be manually trekked or navigated by human pilots. The drone can self-adjust to different elevations and can be maneuvered to steer clear of barriers. This makes it suitable for use in agricultural fields. An agricultural drone is a UAV which is used for agricultural purposes. Such drones can gather data on soil types, plant diseases, irrigation and nutrient requirements as well as monitor crop growth and yield. Agricultural drones employ multispectral sensors to capture electromagnetic radiation in digital images which can be stitched to form spectral reflectance bands, which are then used for calculating Leaf Area Index (LAI), Photochemical Reflectance Index (PRI) and Normalized Difference Vegetation Index (NDVI). Thus farmers can be equipped with aerial images of their fields which helps them to monitor their crops efficiently while also saving on time and labour. An agricultural drone with a carrying capacity of 5 to 10 kg also has the capacity to cover about 1 acre in only 15 minutes, and it can cover more than 60 hectares in a day with a flight range of 1.2 hectares per flight.

Drone Technology in India

Indian agriculture is constantly seeking technological advancement to combat various issues concerning agricultural productivity. Drone technology can be immensely helpful in this regard. Recognizing this, Government of India has shifted focus on the endorsement and promotion of Agricultural drones. It is evident in the Indian federal budget of 2022-23 that India is encouraging Drone Shakti and the use of Kisan drones for agricultural advancement. Since 9th February of 2022, the Ministry of Civil Aviation put a ban on import of any foreign drones in an effort to promote and

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Published: 25 July 2023

encourage Indian drone startups and made in India drones. Indian Kisan Drones in agriculture carry out a varying range of activities like crop assessment, pesticide spraying, precision farming, monitoring crops for diseases, digitalizing land records livestock management and much more. Revenue in the Drones segment amounts to US$23.62m in 2023. The market is expected to grow annually by 8.12%. Some drone models used in Indian agriculture are Garuda Agriculture Spraying Drone – Electric, Garuda Agriculture Spraying Drone – Hybrid, Prime UAV Agriculture Spraying Drone, Agribot Agriculture Spraying Drone, etc.

agricultural applications of drone technology

Agricultural drones provide the farmers with an aerial view of their fields; their crops or harvest. Crops images contain information in the range of infrared and visual spectral. Comparing the different features, farmers can assess their fields in a manner that would not be possible with the naked eye. Information about crop yields, diseased crops, irrigation requirements, intensity of insect and pest attacks as well as pesticide spraying, soil analysis and nutrient application, precision agriculture (like variable rate fertilizer application) is made possible. Site and time specific data can be collected on-demand, whenever required, immediately and conveniently to give results in almost real-time. This encourages farmers to improve crop management by take adaptive measures. By using a drone, a farmer can obtain required information and make better informed decisions. This technology is less labour intensive hence less expensive and time-efficient with reduced operational costs. As compared to satellite-based images, drones provide higher resolution images as they can fly below the clouds covering large areas. There is scope for generating employment by attracting youth who are likely more to be motivated into drone entrepreneurships rather than conventional farming.

Crop assessment: Crops assessment can be done over time with the help of digital images obtained by scanning the fields with the help of multispectral sensors. Plants absorb and reflect light in particular wavelengths, thus generating colour contrast pictures that identify critical problem areas in the agricultural fields.

Crop monitoring for diseases: Farmers or government agencies can monitor plants for pathogens causing wilting, withering and other symptoms. The diseased plants can thus be identified due to the way they reflect light differently. This could help farmers to prepare for any disease outbreaks beforehand.

Plant breeding: Drones have the potential to collect spatial data on plant varieties which can aid in the selection of superior plant genotypes.

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Crop spraying: Drones can spray required amounts of pesticides, fertilizers, etc. uniformly over the crops efficiently, thus minimizing wastage. They can also adjust the distance and height from the ground as required minimizing groundwater contamination with pesticides. It is also argued that spraying with drones is about five times more efficient as compared to using traditional sprayers.

Crop irrigation: Irrigation can be made more convenient with the introduction of drones. Thermal, hyper-spectral, LiDAR or multispectral sensors mounted on such drones can be used to reveal the types of soil and the dry areas in the fields using spectral imaging, which can also help identify damages in irrigation canals or other equipments.

Planting: Drones can be used for placing seeds and nutrients in the soil with the help of shoot pods. Planting with the help of drones is said to reduce the cost by about 85%.

Livestock management: Drones can help monitor farms with a huge number of livestock or track animals grazing over vast stretches of lands. Drone sensors can even be used to spot diseased cattle by detecting body heat.

Geo-fencing: Crops can be protected from animals with the help of drones which can detect stray animals at night through thermal cameras.

Soil and field analysis: Drones images can be used to create 3-D maps for soil analysis which can help determine suitable planting patterns and also maps to detect water requirements and soil nutrient levels.

Locust Control: Locust attacks can be combated by spraying pesticides @2.5 acres/ 15 minutes which is more efficient compared to use of traditional sprayers which are vehicle mounted.

Mechanical or artificial pollinators: It was reported by a New York–based start-up that their drones can increase pollination rates by 25 to 65%. This technology is expected to be useful for application in fruit orchards in the near future.

Weed identification

Scaring of birds away from the fields

Obtaining crop insurance: Farmers can obtain crop insurance more easily when companies are provided with image evidence on the degree of crop failure or damage. Hence drones have a huge capacity to influence the successful implementation of Pradhan Mantri Fasal Bima Yojana (Crop Insurance Scheme) in India.

Transport of products: Drones also have the potential to transport agricultural products like vegetables from the fields to nearby markets.

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Advantages And Disadvantages of Drone Technology In Agriculture

Advantages

- Drones are easy to operate, are low maintenance and have a long lifespan.
- Drone spraying has a reduced cost i.e, 97% less as compared to traditional spraying.
- 90% water is conserved with the use of ultra-low volume spraying drone technology as compared to traditional methods.
- About 30% of pesticide wastage is prevented a result of high degree atomization when spraying, Drones can spray the chemicals at different levels of the plant.
- Since drones can be operated at a distance by the drone pilot, exposure to harmful chemicals is limited.
- Drones have a high field capacity and can efficiently spray about 50 to100 acres a day with an advantage of 30 times more in comparison to traditional sprayers.

Disadvantages

- Agricultural drones are dependent on weather for the good quality digital imaging.
- Drones or unmanned aerial vehicles share airspace with manned aircrafts like airplanes so there could be interferences to flights in the shared airspace.
- Agricultural drones have a short flight time of 20 to 60 minutes and they are limited by law to a 400 feet altitude.
- Internet connectivity- Arable farmlands have limited online coverage and there are problems with internet availability.
- Knowledge and skill- The images collected must be translated into useful and comprehensible information through skilled analysis. So there is a need for more training and skilled professionals in drone technology.
- Since farmers lands are exposed to the public, there could be misuse of information and encroachment of personal privacy.

Government Support

There is various financial support facilities made available by the government of India for the purchase of drones. In this regard, 2014-15 saw the implementation of Sub-Mission on Agricultural Mechanization (SMAM) under the Ministry of Agriculture and Farmers Welfare, Government of India. And in 2021, SMAM- Drone Technology component was started.

Financial Assistance	Given to	For the Purpose
100% of the cost of drone up to a maximum of Rs. 10 lakhs per drone	Government organizations	To purchase drones
Upto 75% of the cost of agriculture drone	Farmers Producers Organizations (FPOs) drone	For purchase of drones for demonstrations on the farmers' fields.
A contingency expenditure of Rs.6000 per hectare for hiring Rs.3000 per hectare for purchasing drones	Implementing agencies that do not want to purchase drones	To hire drones for demonstrations from Custom Hiring Centres, Hi-tech Hubs, Drone Manufacturers and Start-Ups.

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40% up to a maximum of Rs. 4.00 lakhs are provided.	Custom Hiring Centers under Cooperative Society of Farmers, FPOs and Rural entrepreneurs	For the purchase of drones to give farmers on a rental basis
@ 50% of the cost of drone up to a maximum of Rs.5.00 lakhs per drone.	Agriculture graduates	For establishing Custom Hiring Centers
@ 50% of the cost up to a maximum of Rs. 5.00 lakhs	Small and Marginal, Scheduled Caste/Scheduled Tribe, Women and North Eastern State farmers	For individual purchase of drones
@ 40% up to a maximum of Rs. 4.00 lakhs.	Other farmers	For individual purchase of drones

Future Prospects

The past few years have thrust drone technology on the right track to progress in India making it leverage to a big change that is to come in the following years. There is an inclination of the agriculture sector towards incorporating drone technology and uncovering its full potential to benefit the farmers and entrepreneurs. There are many future prospects that call for the collaboration of Artificial Intelligence (drone technology) and agriculture as addressed below-

- Revolutionizing cargo delivery- Drones have the potential to revolutionize the cargo delivery system. There is scope for commercial drones with more load capacities to move products directly from the fields to the market and vice versa. Although there is much to be done to establish such systems, there lies a good advantage in its inception where market delivery could be done in less time, while minimizing damage and thus leading to increase in income of farmers.
- Mechanical pollinators- Drones as mechanical pollinators could serve as an affordable technology that has the potential to address the most important pending national and global issue of establishing food security.
- Attracting youth in agriculture- A huge challenge lies in retaining rural youth in agriculture. However, there are ways to attract the population of such youths by advertising and encouraging them into employment opportunities as drone entrepreneurs and modern farmers.
- The Government is also taking measures to support the progress of drone technology by announcing a ban on the import of drones from foreign countries with the idea of encouraging the rise of drone industry in India. Research estimates that the global agriculture drone market will grow at 35.9% CAGR to gain $5.7 billion by the year 2025. There is however, the need

to integrate a system of well-trained professionals in the delivery of drone services to farmers at a reasonable price to make it more accessible.

- The vision in the near future sees drones operating fully autonomously with the help of artificial intelligence systems instead of manual operators. Hence, we can all hopefully look forward to taking flight towards a new era of agricultural advancement with Artificial intelligence and Drone technology.

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